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TITLE: Cavity resonator

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-P:atented Nov. 16, 1948 21453 760 UNITED STATES PATENT OFFICE @21453,760 CAVITY RESONATOR John C. 'ScheReng, Interlaken, @N. J., assignor to Bell Telephone Laboratories,. Incorporated, New York, N. Y., a corporation of New York Application March 2, 1945, Serial N6. 580,517 5 Claims. (Cl. 178--44) 2 This invention relates to cavity resonators and more particularly to improvements in the energy transmission connections to cavity resonators. An object of the invention is to provide a cavity resonator with energy transmission connections which - @will accentuate oscillations of a desired mode while discriminating against and tending to suppress those of undesired modes. Another object of the invention is to provide eirelit connections for a cylindrical cavity resonator whichwill enhance oscillations.of TE01 modes while discriminat-ing age@inst oscillations of TE11, TE1m, TE2m and other transverse electric modes. An additional object of @the invention is to pro- 1.1 vide circuit connections between a wave guide and a cavity resonator which shall discriminate against oscillations of undesired TM modes. Cavity resonators serve in electrical microwave technique as selective devices in a. rnanner some- 2) what analogous to that of tuned circuits at lower frequencies. However, because @of their dis- tributed reactances, large cavities are in general suscepti ble of a large number of different modes of oscillation. Most of these modes are eff ective 27) at frequencies ivhich may be relatively remote from a desired predetermined mode of oscillation but some may prove troublesome because adjacent in frequency to the desired oscillatiops. idoreove r, in the case of oscillations in perfect circular cylindrical resonators, TEon, and TMim mode oscillations occur in pairs at identical fre- quencies , thus rendering their separation rather difficult. What is more, the different modes of oscillatio n of a cavity @esonator which occur at 35 the same resonance frequency appear to Interact so that energy dissipation by a resistance eff ective upon one mode of oscillation may sap energy from the other. The manner in which various modes Of OSCilla@- 40 tion interact is attributable i-n part to coupling occurrin g at the entrance by which energy is sup_ plied to the resonator. As an

illustration, suppose that a pulse of radio frequency energy is applied for one microsecond through a small loop 45 or turn of wire at the end of the inner conductor of a coaxial line, this turn being oriented in such a way as to excite simultaneously two modes of oscillation of the cavity, one mode desired and the other not. During the period of decay following the pulse, the desired mode (the undesired also) will cause a current to flow in the loop. But the same loop by assumption is coupled to the undesired mode, and hence power will be transferred to the undesired mode. Hence the factors causing damping in the undesired mode will contribute to that in the desired mode. In accordance with the invention, discrimination in favor of the desired mode of oscillation of a cavity resonator and, against an undesired mode is attained by coupling the resonator to its feed line or to its output circuit or to both by a multiple point coupling, the coupling points being so chosen as to be in phase agree-ri-ent for the desired model of oscillation and to be in phase disagreement for oscillations of undesired modes. In this specification, transverse electric and transverse magnetic modes will be designated respectively as TE and TM, and in the case of right circular cylindrical resonators the subscripts: n, m and l will be used, referring respectively to the number of 360-degree phase changes in the circumferential direction and 180-degree phase changes in the radial and length directions. Hence, TE01 mode oscillations in a right circular cylinder describe an oscillation having a standing wave pattern such that its electric vectors are transverse to the cylinder axis, there is no change in phase circumferentially; there is a single half-wave change in phase in radial direction and there are nine halfwave changes in the longitudinal or axial direction. In the drawing: Fig. 1 shows in perspective a cavity resonator involving one embodiment of the invention; Fig. 2 is a plan view of the lower end of the structure of Fig. 1; Fig. 3 is a section along a vertical plane passing through the zigzag broken line 3-3 of Fig. 2; and Fig. 4 is a section along the line 4-4 of Fig. 2. Referring to the drawing, a cylindrical cavity resonator 10 designed to operate in TE01.9 mode is shown in Fig. 1. In order to excite TE01 mode oscillations through the end plate 11 a plurality of coupling apertures 12 in this case four, are provided. As shown in Fig. 2, the apertures are located at equally spaced points along the perimeter of a circle of about four-tenths the radius of the end plate, at a distance from the center where the electric field of the TE01 mode is strong relative to that at the circumference and center. These apertures in the embodiment disclosed are in the form of radially directed slots of the order of one-eighth inch in length and one thirtyseconds inch wide. The main energy transmission system which may serve as a feed line for the resonator is a wave guide 14 designed to